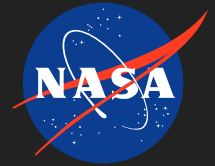


## Autonomous Navigation in GNSS-Denied Environments, Phase I

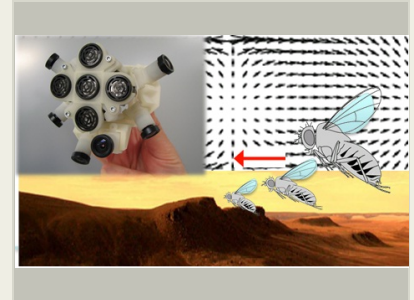
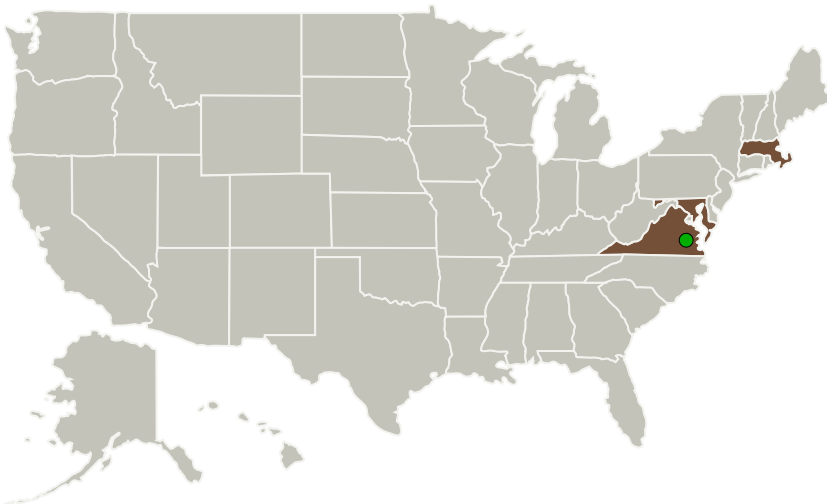
Completed Technology Project (2013 - 2014)



## Project Introduction

Aurora proposes to develop a vision-based subsystem for incorporation onto Mars vehicles in the air (VTOL) and on the ground. NOAMAD will be an embedded hardware device with associated firmware for payload-limited UAVs, performing autonomous navigation, obstacle avoidance, guidance using bio-inspired methods, and communication of information between agents within the autonomous team. NOAMAD will transition University of Maryland methods for insect-inspired, lightweight, vision- and optical sensor-based navigation methods into a subsystem that enables expansion of the exploratory capability of the vehicles on which it is installed. The subsystem will provide (1) localization (without a global navigation system or compass) using optic-flow based odometry combined with landmark detection, (2) obstacle detection and avoidance using optic flow, and (3) autonomous guidance using position information together with bio-inspired behaviors. Taken together, these functions will allow air and ground vehicles to work together to achieve progressively refined maps of an exploration region.

## Primary U.S. Work Locations and Key Partners



Autonomous Navigation in  
GNSS-Denied Environments  
Project Image

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Organizational  
Responsibility**Responsible Mission  
Directorate:**

Space Technology Mission  
Directorate (STMD)

**Responsible Program:**

Small Business Innovation  
Research/Small Business Tech  
Transfer

## Autonomous Navigation in GNSS-Denied Environments, Phase I

Completed Technology Project (2013 - 2014)



Organizations Performing Work	Role	Type	Location
● Langley Research Center(LaRC)	Supporting Organization	NASA Center	Hampton, Virginia
University of Maryland-College Park(UMCP)	Supporting Organization	Academia	College Park, Maryland

Primary U.S. Work Locations	
Maryland	Massachusetts
Virginia	

## Project Transitions

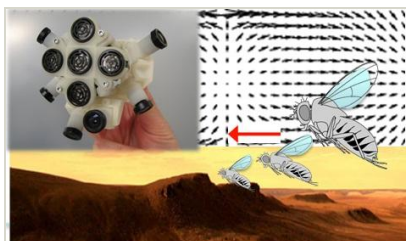
▶ **May 2013:** Project Start

✓ **May 2014:** Closed out

## Closeout Documentation:

- Final Summary Chart(<https://techport.nasa.gov/file/140486>)

## Images



## Project Image

Autonomous Navigation in GNSS-Denied Environments Project Image  
(<https://techport.nasa.gov/image/136272>)

## Project Management

## Program Director:

Jason L Kessler

## Program Manager:

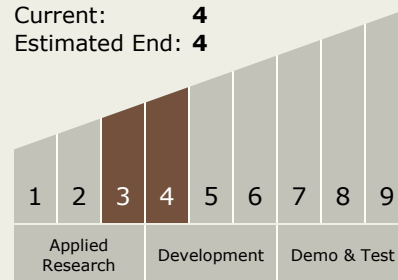
Carlos Torrez

## Principal Investigator:

Terrence Mckenna

## Technology Maturity (TRL)

Start: **3**  
Current: **4**  
Estimated End: **4**



## Technology Areas

## Primary:

- TX04 Robotic Systems
  - TX04.1 Sensing and Perception
    - TX04.1.2 State Estimation

## Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System